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(54) Title: BONDING LAMINATIONS


(57) Abstract

A process for producing laminated sheet glass and in which a suitable interlayer disposed between two sheets of glass material is fed through one or more sets of pinch rollers and heated, as it moves, to cause the interlayer to bond to each sheet; characterised by the features: (a) that both sheets and the interlayer are initially unbonded to one another and are heated and rolled simultaneously throughout the process; and (b) that the interlayer is heated at least to and preferably above its plastic temperature.


* See back of page

# BONDING LAMINATIONS

## Field of the Invention

The invention relates to a process and apparatus for laminating sheets of glass.

Laminated glass is presently made by pressing together the sheets which are to form the laminated structure with a bonding plastics interlayer between them. The known process involves heating the component sheets under pressure in an autoclave at a raised temperature. The sheets are subjected to this temperature and pressure for several hours and then allowed to cool undisturbed for a further considerable time.

As a practical matter, the use of an autoclave restricts this technique to a batch process. The continuous raising of temperature and pressure and subsequent release to atmosphere at the end of each cycle is wasteful in energy. An object of the present invention is to provide a glass laminating process which is continuous and requires less energy to laminate a given area and thickness of glass than known processes, especially the ones involving a final-stage autoclaving.

## Review of Art known to the Applicant

There is extensive prior art dealing with glass laminated processes of the kind in question. Amongst those prior documents personally known to the applicant at this stage are the following:

5. GB 1 312 136 (THOMAS BENNETT)

Is not a laminating-only process; this ends with an autoclaving step "occupying five hours" and hence is anything but a continuous-production system.

6. US 3 647 592 (MALLORY & CO)

Shows, again, a method of bonding a (specifically) polyester film to a (i.e. single) substrate; not sandwich-laminating a glass sheet. Glass is said to be one suitable substrate but there's no specific example given; and no suggestion of simultaneous-sandwich-laminating. Vacuum-preheating of the polyester is said to be essential (see claim 1). Electrifying (claim 2) highly advantageous. Pressures of "about 2 psi" are used to press the film to the sheet.

Summary of the Invention

It is clearly known from the prior art reviewed above to produce a bonded composite laminate by disposing a suitable interlayer between two sheets of material and rolling and heating these components to cause them to bond to one another. But what is not known is such a process in which the interlayer and two sheets of glass are initially unbonded to one another and are heated and rolled simultaneously throughout the process with the interlayer being heated at least to and preferably above its plastic temperature.

If the process is characterised by the just-recited features then the sheets and the interlayer will bond sufficiently for any further heat treatment - such as autoclaving - to be unnecessary; thereby turning a multi-stage batch-production process into a single-stage continuous-production one as well as achieving considerable energy savings and optimising the efficiency of the whole process.

Brief Description of the Drawings.

Figure 1 is a side view of laminating apparatus in accordance with the invention;

Figure 2 is a end view of the apparatus of Figure 1;

Figure 3 is a plan view of the apparatus of Figure 1;

Figure 4 is a schematic diagram of a hydraulic system used to urge compressing rollers together; and

Figure 5 is a schematic representation of the configuration of heating elements in the apparatus of Figure 1.

Description of the Preferred Embodiment

Referring to Figures 1 to 3 of the drawings, laminating apparatus for bonding a laminate 11 of sheets of glass and an interlayer of hot melt adhesive comprises a bed 10 on which are mounted a set of four adjustable lower pinch rollers 12. Generally aligned with a plane defined by the top of the lower pinch rollers 12 is a set of conveyor rollers 14. An upper pinch roller 16 is adjustably mounted above each lower pinch roller 12. Each of the rollers 12 and 16 comprises a steel inner body covered by a 3 mm layer of silicone rubber, giving an overall diameter of 200 mm. The rollers are spaced with 500 mm between centres.

Road, Ealing, London, W54 TW as "FSR Elements" provide adequate control of the heat.

It has also been found that other forms of heating can be used, e.g. common electrical bar elements can be used in place of the more expensive ceramic elements although with less precise control. As a compromise an assortment of both types of heater is preferable in which the ceramic elements are used in the middle of each bank and the electric bar elements used outside of these.

The wattage of each row of heaters, as indicated by the broken lines in Figure 5, is 375, 325, 250, 200, 250, 325 and 375 watts from one end of the bank of heaters to the other. It is possible to use banks of heaters switched on and off using on/off control, but the degree of control obtained by the above arrangement is preferable.

The rollers 12 and 16 are driven by a three-phase electric motor 35 and a triple reduction gearbox 36 having a 12.5:1 ratio controllable to rotate the rollers via gear wheels 38 at between 1 and 12 rev/min. Clearly, the thickness of the composite of materials making up the laminate will determine the speed of the motor for a given case along with the power of the heating elements.

The banks of heaters 34 are mounted between the rollers 12 and 16 within reflective aluminium foil lined insulated compartments 40 to enhance their efficiency. It may also be preferable to install a vent flap in the

The hot melt adhesive used is a plastics material known as polyvinylbutyral (PVB). In place of this could be used ultra-violet stabilised styrene-butadiene block copolymer (K-resin), polycarbonate or ethylene-vinyl acetate copolymer (EVA). These materials require differing temperatures and pass rates according to their characteristics. The polycarbonate and the EVA also tend to go cloudy if the layer is too thick and this needs to be taken into consideration when a thickness of laminate is being determined.

As an example of the use of the apparatus according to the invention, a laminate of two pieces of 3 mm thick glass and an inner hot melt adhesive layer of .38 mm PVB were laminated using the above apparatus.

Before proceeding with the actual laminating process a black anodised aluminium sheet is passed through the apparatus. It is found that the warmed up heaters tend to cause the heat inside the apparatus to accumulate at either end. By passing the aluminium sheet through, the localised heating is more evenly distributed before the glass enters the apparatus.

The rollers were set to a gap of 1 mm less than the total thickness of the laminate. The piston and cylinder devices applied a pressure of up to about 3,000 psi on each roller pair which is equivalent to a localised loading on the layers of glass of about 10 tonnes. The temperature of the bonding layer was raised to between 120 and 150 $^{o}$C or even up to 180$^{o}$C. The resulting bonded laminate was clear when it emerged

The necessary sensors in such an automated plant would connect to a controller which monitors and adjusts the conditions in line with the equasion of temperature, time and pressure arrived at by experimentation and development of the specific apparatus built in any one production instance.

Other modifications would of course be made to the apparatus illustrated in final production mode. For example the vent flaps previously referred to would eventually together with the heaters and drives to each roller be microprocessor controlled. And the receiving table 44 may well comprise an equivalent part of a continuous system.

It will also be appreciated that the so-called hot melt adhesive layer is the "interlayer" of the invention in its broadest aspect.

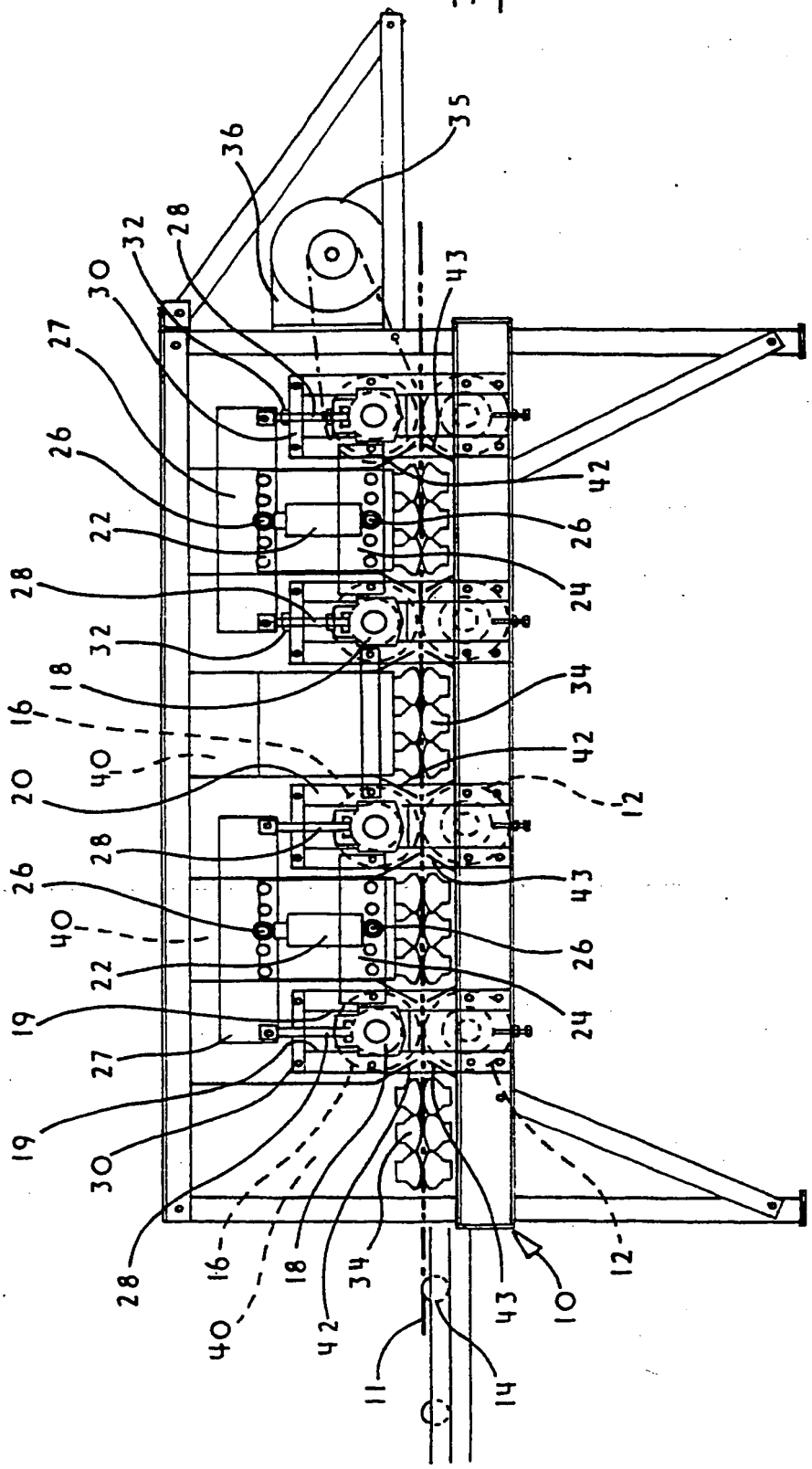
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Fig. 1

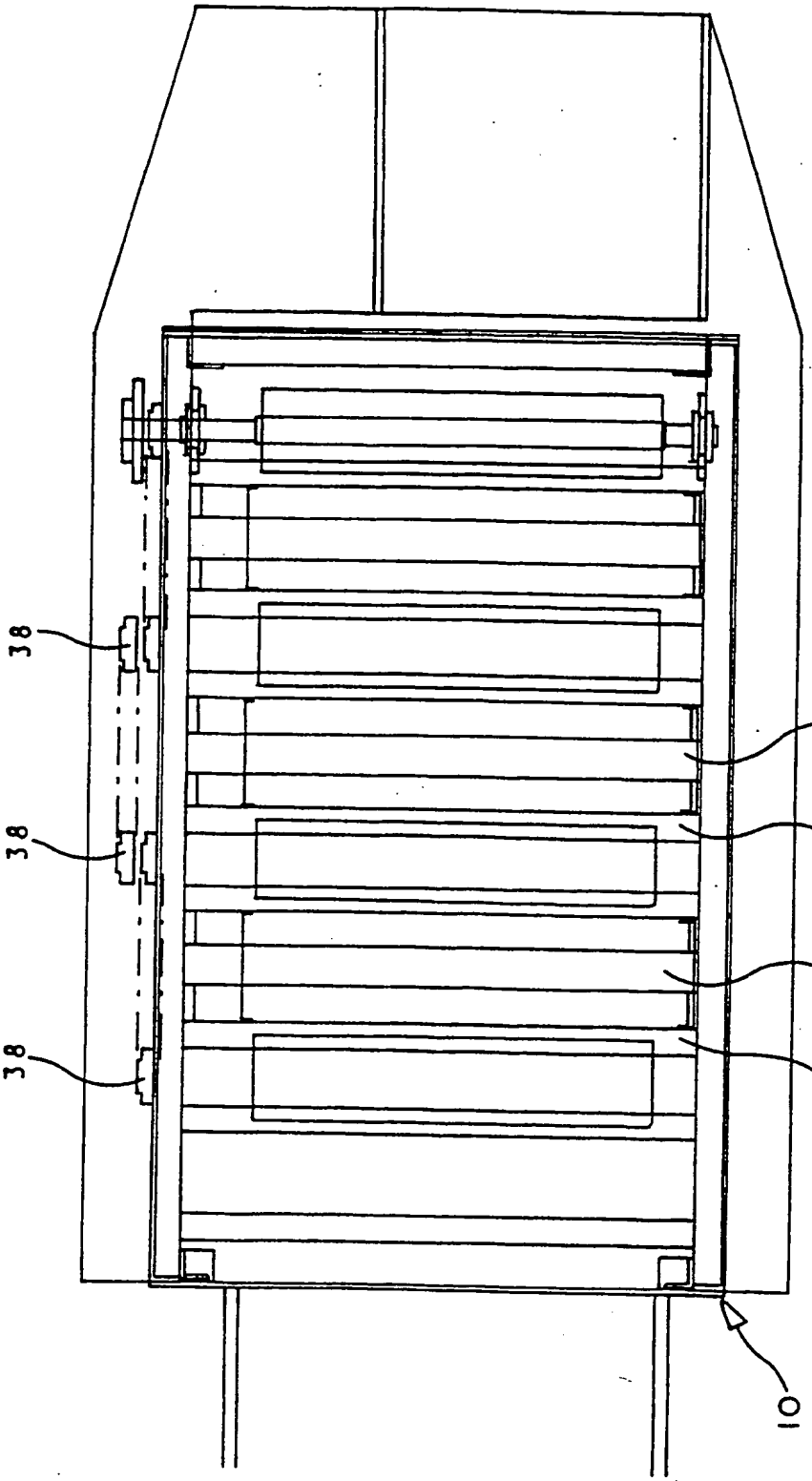


Fig. 3

# INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 90/01197

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: B 32 B 17/10, C 03 C 27/12

## II. FIELDS SEARCHED

Minimum Documentation Searched [7]

| Classification System | Classification Symbols |
|---|---|
| IPC[5] | B 32 B, C 03 C |

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

## III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

| Category [10] | Citation of Document, [11] with indication, where appropriate, of the relevant passages [12] | Relevant to Claim No. [13] |
|---|---|---|
| X | US, A, 2279112 (J.L. DRAKE et al.) 7 April 1942 see column 1, lines 31-41; column 5, line 62 - column 6, line 10; lines 27-74; figure 1 -- | 1-3,5,6 |
| X | US, A, 2235958 (J.H. BOICEY) 25 March 1941 see column 4, lines 42-75; figure 5 -- | 1-3,5,6 |
| X | US, A, 2163648 (G.B. WATKINS et al.) 27 June 1939 see column 3, lines 18-39; figure 1 -------- | 1-3,5,6 |

[10] Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| 11th October 1990 | 15. 11 90 |
| **International Searching Authority** | **Signature of Authorized Officer** |
| EUROPEAN PATENT OFFICE | M. PEIS |

Form PCT/ISA/210 (second sheet) (January 1985)